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# BUILDING RESEARCH NOTE

## SMALL-SCALE FIRE TEST OF 6 INCH WALL PENETRATED BY TELEPHONE CABLES

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A positive pressure fire test was carried out on two small-scale 6 in. thick, high-temperature concrete walls penetrated by 13 multi-core and 6 coaxial telephone cables. Alumina-silica-ceramic bulk fibre, capped at the exterior face with cementitious sealant, constituted the firestopping around the cables. The penetrations proved satisfactory except for those involving the two largest cables, which gave unacceptably high temperatures after approximately 2 hr of test. Sealing the ends of the cables could have further improved performance.

The test reported in this note was carried out at the request of Bell Canada to supplement information gained from a series of similar tests, conducted in 1974, sponsored jointly by DBR and Bell Canada. The object of the test was to determine whether penetrations by selected telephone cables would impair the fire containment integrity of a high-temperature concrete wall 6 in. thick, for a period of 2 hr. Failure criteria were as follows: temperatures exceeding 1000°F at the unexposed surfaces of the cables and development of openings greater than 0.1 sq in. (65 $mm^2$).

## TEST SPECIMENS

The two walls, one installed at each end of the furnace consisted of high-temperature concrete, 16 in. square by 6 in. thick (406 mm x 152 mm), of density approximately 60 lb/cu ft (961 $kg/m^3$). Figures 1 and 2 illustrate the specimen walls (after test), penetrated by the cables specified in Table 1. Firestopping was by alumina-silica-ceramic bulk fibre and one of three cementitious sealants. The cables were separated from each other by at least 3/4 in. (19 mm). The fibre packing was inserted from the exterior (unexposed) face of the wall and was allowed to protrude a little beyond the inside face. Packing was continued until the fibre wool extended to within an inch of the exterior face. The cementitious sealants listed in Table 2 were then used to cap the openings. There were no cables associated with openings F, H and J.

Small amounts of a pliable plastic sealant were applied at two locations on the exterior face of opening G and one on opening E (see Figures 1 and 2).

In previous tests the unexposed ends of the cables were capped to prevent the flow of hot gases through the cables when testing under positive pressure. As shown in Figures 1 and 2, this procedure was not followed during the current test.

## TEST PROCEDURE AND RESULTS

The furnace was operated for slightly over two hours, temperatures following the ULC S101 (ASTM E-119) time-temperature curve. Within 4 min of the start of the test, a positive pressure of 5 mm WG (Water Gauge) was established within the furnace; this was maintained (to within ± 10%) for the duration of the test.

Temperatures were measured periodically with a 20 gauge Teflon insulated chromel-alumel thermocouple and are recorded in Figure 3. Adopting the failure criterion of 1000°F (537.8°C) at the unexposed surfaces of a cable, penetrations G5 and G7 failed at approximately 119 min and 122 min respectively. Based on the excessive opening criterion, G5 was the only penetration not meeting the requirement; failure occurred at 118 min.

Toward the end of the test, hot gases were seen to be issuing from the end of cable G5, between the wires and the metal sheath. Very high temperatures had developed resulting in the destruction of the insulation of most of the individual pairs. Subsequent examination of cables B and D, which were of a similar type, showed that they had exhibited the same behaviour to a lesser extent.

The exterior jackets of several of the metal shielded cables developed blisters beneath them. The first recorded was beneath D at 57 min and the blister punctured 2 min later. At 72 min, G5 developed a small blister that was dripping at 91 min. Over the same period, a blister had also developed beneath cable B. Rapid development of a blister beneath G4 was recorded at 84 min.

Some time after the test, the condition of the three capping materials was examined. The Flintkote "top 'n bond" appeared substantially unaffected by the exposure and, to a lesser extent, the same was true of the "Water Seal" quick-set cement. Although retaining reasonable strength, the vermiculite/sand/cement mixture had shrunk, however, and had left a crack at the perimeter of each penetration.

## CONCLUSIONS

The fire containment performance of 6 in. concrete wall specimens, including penetrations by various telephone cables ranging in diameter up to 3 in. (76 mm), remained satisfactory for almost 2 hr when exposed in a furnace operating at positive pressure. Firestopping involved alumina-silicate-ceramic bulk fibre and 1 in. cementitious capping. An experimental vermiculite/sand/cement capping was found to behave more poorly than two proprietary mixes.

## ACKNOWLEDGEMENTS

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TABLE 1

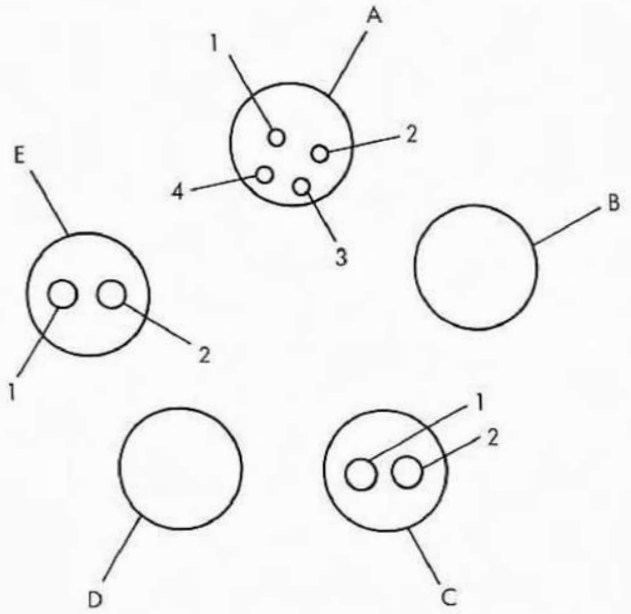
TEST CABLES

| Test Locations | Name | No. of Pairs and Gauge | OD | Shield | Jacket |
|---|---|---|---|---|---|
| C1, C2, E1, E2, G4, G7 | Air core polyolefin insulated cable | 50/19 AWG | 1.12 in. (28.4 mm) | 0.2 mm (0.008 in.) aluminium tape | Polyethylene |
| B | Paper-pulp insulated exchange cable | 900/22 AWG | 2.68 in. (68.1 mm) | 0.2 mm (0.008 in.) aluminium tape and 0.15 mm (0.006 in.) steel tape, applied longitudinally, steel soldered | Polyethylene |
| D | | 3600/26 AWG | 3.1 in. (78.7 mm) | | |
| G5 | | 1800/26 AWG | 2.38 in. (60.5 mm) | | |
| G1, G6, G9 | D Inside Wiring Cable | 16/24 AWG | 0.33 in. (8.4 mm) | | PVC |
| G8 | | 50/24 AWG | 0.53 in. (13.5 mm) | | |
| A1, A2, A3, A4, G2, G3 | CATV Foam-dielectric coaxial cable | | 0.487 in. (12.4 mm) | (Outer conductor aluminium) | Polyethylene |

TABLE 2

CEMENTITIOUS CAPPING

| Test Location | Capping |
|---|---|
| A, C, D, H | Flintkote "top 'n bond" |
| F | "Water Seal" quick set cement |
| B, E, G, J | Vermiculite, sand Portland cement (3:1:1) |




CABLE NUMBERING KEY

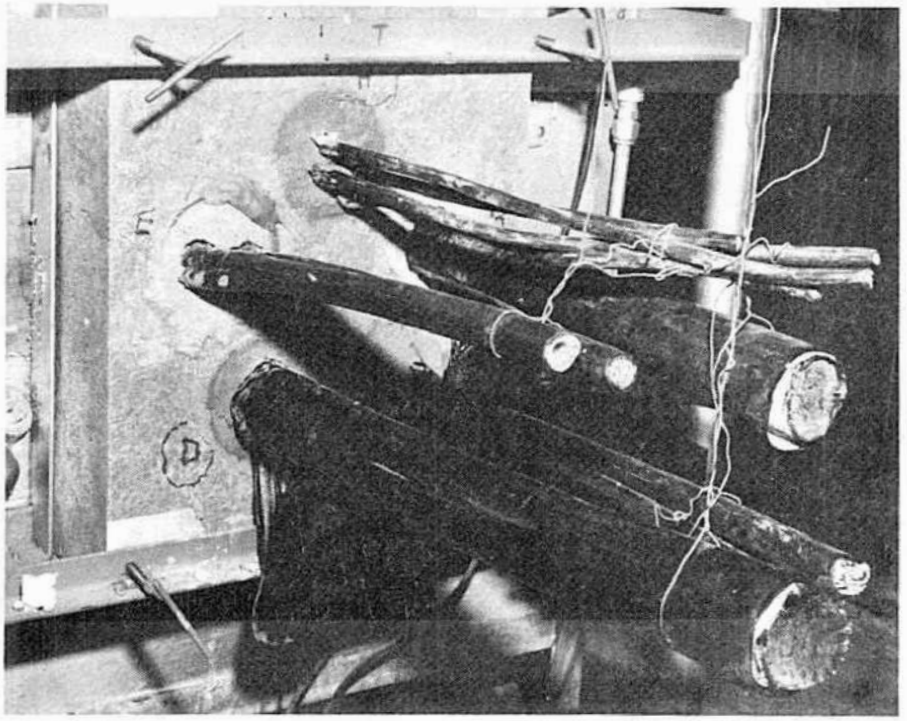
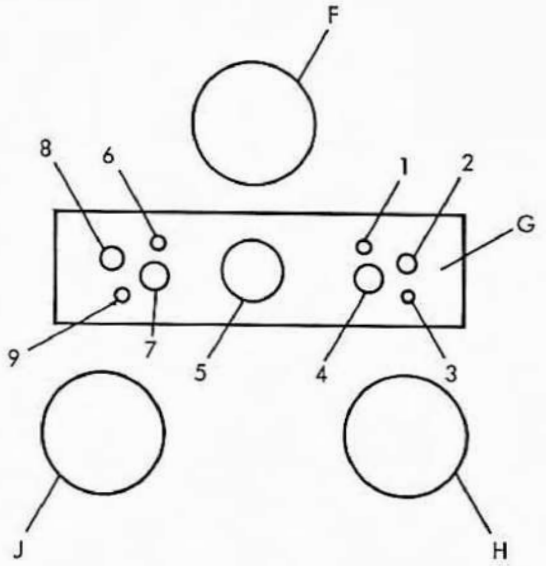


FIGURE 1

UNEXPOSED FACE OF WALL SPECIMEN NO. 1 AFTER TEST

BR 5510-1

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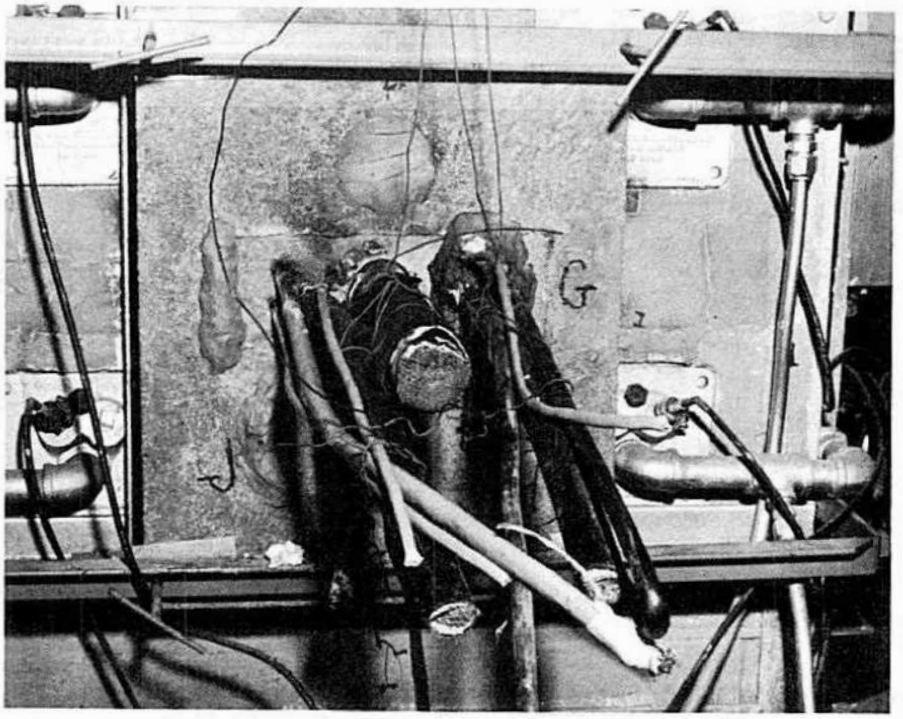


FIGURE 2

UNEXPOSED FACE OF WALL SPECIMEN NO. 2 AFTER TEST

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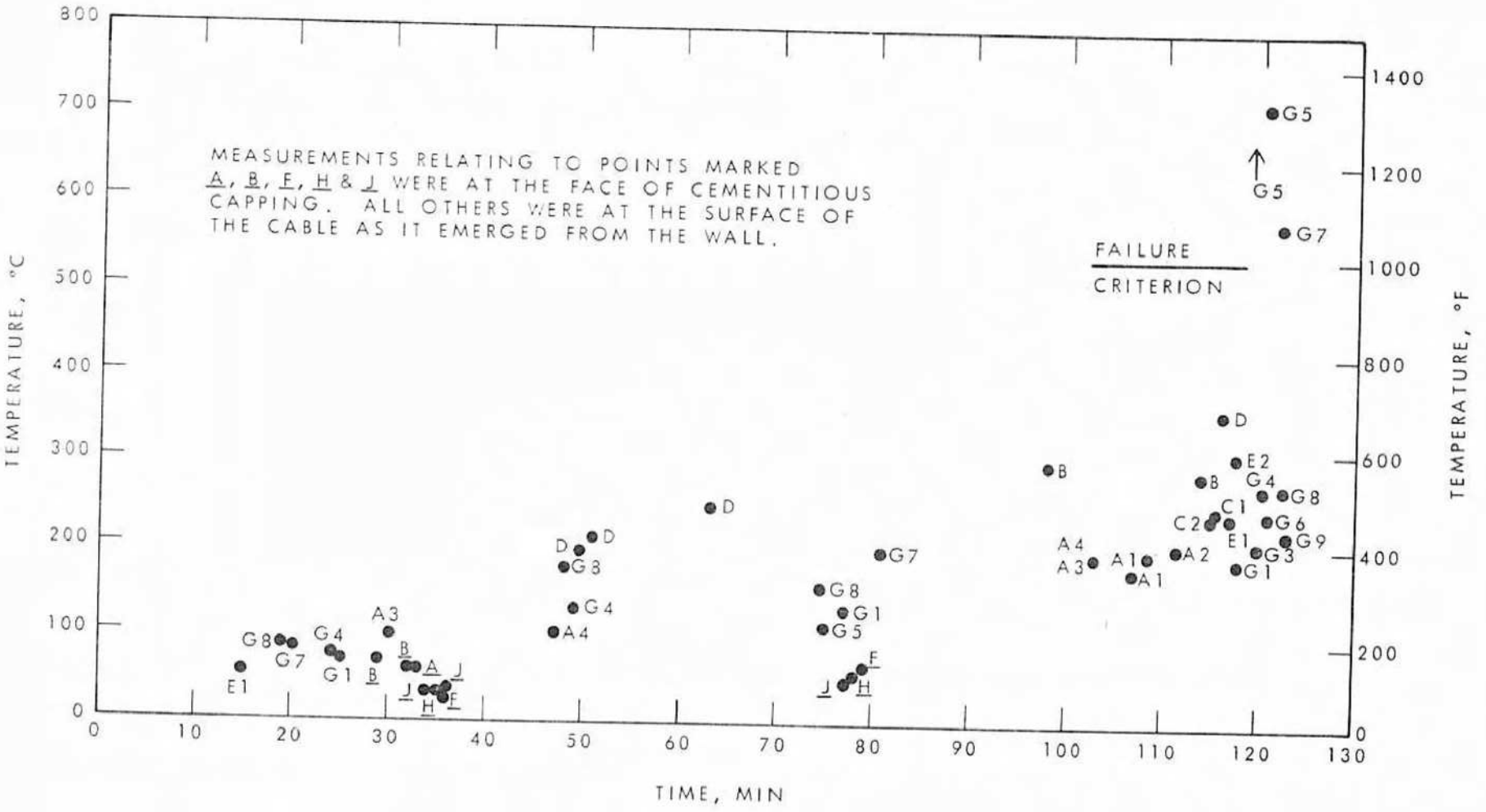


FIGURE 3

TEMPERATURE MEASUREMENTS

BR 5510-3